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LEAD AND ZINC ORES NEAR PHOENIXVILLE,  
CHESTER COUNTY, PENNSYLVANIA.

By

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Location.

All the lead and zinc mines in Chester and Montgomery counties are near Phoenixville, which is 25 miles west of Philadelphia on Schuylkill River. Most of the mines are two miles south of Phoenixville near Pickering Creek; two mines are four miles east of Phoenixville between Perkiomen Creek, Mine Run, and Audubon (formerly Shannonville), in Montgomery County. The map on page 12 shows the location of the mines.

With the exception of a little sporadic development very recently, no mining has been done here in 50 years. The underground workings are inaccessible and there are no places where the lodes can be seen at the surface.

History of Operations.

Lead mining in this district began about 1808 and there is definite information that "The Perkiomen Mining Company" was mining lead ore in 1809. Ore was first discovered along Mine Run, one-half mile northwest of the present village of Audubon and an 80-foot shaft was sunk. The company drifted 56 feet along the vein and drove a drainage tunnel 356 feet from the bottom of the shaft to its outlet near the creek. Considerable ore was found but owing to misunderstandings among individuals the works were abandoned in 1810.

There is a break in the record of mining between 1826 and 1851, but we learn that when in 1835-36 standard weights and measures of American metals were ordered by Congress for the U. S. Treasury the zinc used was obtained from a mixture of the Perkiomen and Franklin Furnace, N. J. ores. This seems to have been the first utilization of







American zinc ores. Up to that time lead and zinc ores had been worked solely for the lead content.

On February 15, 1851 a charter was granted The Perkiomen Consolidated Mining Company. The company organized "for the purpose of mining, selling, or smelting copper and lead ores, and erecting the necessary buildings and machinery for such purposes, and as such, shall have power to lease or purchase the Perkiomen and Ecton mines, and certain other mines and mining lands, and all other estates of what kind soever, real, personal or mixed, situated in the counties of Montgomery and Chester." The company was capitalized for \$300,000. On March 19, 1851, the capital stock had been subscribed and a meeting of the stockholders was held in Philadelphia.

About this time or perhaps a little earlier, lead and zinc ores were discovered along Pickering Creek, south of Phoenixville. In 1850, the General Assembly passed acts of incorporation for the Chester County Mining Company, and for the Montgomery County Mining Company. The Wheatley Mining Company was also incorporated about the same time, for it started mining operations early in 1851.

Between 1851 and 1855 lead and zinc mining was actively carried on by a number of different companies in the two mining districts of Montgomery and Chester counties. From 1855 to 1865 and perhaps a few years later some work was done on different properties at intervals. During the most active period more than a dozen separate and distinct lodes were prospected and considerable work was done on most of them. The lode most extensively worked was the Wheatley. Three companies, the Wheatley, Brookdale, and Phoenix operated on this lode but in 1855 consolidated under the name of the Pennsylvania Lead Company.

A later consolidation was effected about 1864 in which the New York and Boston Silver Lead Company acquired the Wheatley, Brookdale, Charlestown, Morris, and perhaps other properties. Considerable work was done in 1864 and 1865 in reopening the Wheatley and Brookdale mines. The date when work stopped is not known, but it is believed that all lead and zinc mining in both Montgomery and Chester counties had been abandoned before 1870.

In 1918 the Eastern Mining and Milling Company leased the property on which the Chester County lode is located, and dewatered and retimbered part of the old workings. Some stoping and additional drifting was done and a small mill was built. Work was continued for about two years and some high grade ore was shipped.

The Pennsylvania Lead and Zinc Company and the Great Eastern Mining and Manufacturing Company are now trying to raise money for reopening some of these old mines.







## Geological Occurrence of the Ore.

For many years there has been no opportunity for study of the underground geology except in the Chester County lode; consequently descriptions of the geological character of the lodes must be based on reports prepared during the time of their active exploitation. For that reason the report of H. D. Rogers in his "Geology of Pennsylvania" is the principal source of information extensively quoted here. Some lodes are in the Stockton formation of Triassic age, which is mostly red shale; others are in gneisses of both sedimentary and igneous origin. The Charlestown and Buckwater lodes lie within the area of Pickering graphitic gneiss, an altered sedimentary formation which contains workable beds of graphite a few miles farther west. The Montgomery, Chester County, Wheatley-Brookdale, Pennypacker, and a few unimportant unnamed lodes are in monzonite and granodiorite. The Napoleon and Pethericks Penn Mining Smelting Company lodes are included with the Baltimore gneiss.

Rogers made a report\* on the district in 1853 from which the following facts are derived.

"The metalliferous lodes from the Perkiomen mine in Montgomery County to the Charlestown mine in Chester County occur not far from the boundary between gneisses and the red shale and sandstone formation. Some lodes are in one, some in the other, and some in both formations. Veins in the gneiss bear lead as their principal metal, whereas veins in red shale carry ores of copper; Zinc ores prevail in both sets of veins. The Perkiomen and Ecton, United Mine, Shannonville South lodes, a lode on French Creek and one at Port Kennedy, and the Morris lode near Phoenixville are predominatingly copper-bearing, and without exception are in the red shale formation.

"On the other hand the Wheatley and Brookdale, Chester County, Montgomery, and Charlestown lodes are lead-bearing and lie within the gneissic rocks. These relations are generalizations from which some veins deviate.

"The lodes cut or intersect the beds of the gneiss, following neither strike nor dip. They are remarkably similar in course ranging N. 32° - 35° E. and they dip to the southeast.

"The predominant material in all these lodes is quartz, then pyrite and barytes. The different lodes differ more, perhaps, in the amount and distinctness of the gossan than in almost any other particular. Sundry assays of its gossans show an average of 10 ounces of silver to a ton."

## Mineralogical Character of the Ores

The Phoenixville mines have long been known to mineralogists for the variety, perfection and beauty of mineral specimens found there.

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\* Rogers, H. D. Geology of Pennsylvania, Vol. II, pp. 699-705, 1858.





Even yet the old mine dumps are frequently visited by mineral hunters who are usually successful in finding some interesting specimens. The following minerals have been reported from the mines.

### Lead Minerals

#### Common

Galena  
Pyromorphite  
Anglesite  
Cerussite

#### Rare

Wulfenite  
Descloizite  
Mimetite  
Vanadinite  
Stolzite  
Mendipite?

### Zinc Minerals

#### Common

Sphalerite  
Calamine

#### Rare

Smithsonite?  
Hydrozincite

### Copper Minerals

#### Common

Chalcopyrite (some  
auriferous)  
Chalcocite  
Cuprite  
Malachite  
Azurite

#### Rare

Covellite  
Native Copper  
Melaconite  
Pseudomalachite  
Erythrite  
Chalcanthite  
Bornite  
Chrysocolla  
Libethenite

### Other Minerals.

#### Common

Quartz  
Calcite  
Aragonite  
Dolomite  
Ankerite  
Barite  
Pyrite  
Limonite  
Goethite  
Fluorite

#### Rare

Gersdorffite  
Bournonite  
Hematite  
Native Silver  
Sulphur  
Amethyst  
Chalcedony  
Greenockite  
Arsenopyrite  
Diopside?  
Marcasite?  
Millerite?

Galena, pyromorphite, and sphalerite are the only minerals of economic importance in all the mines worked for lead and zinc. Chalcopyrite is the only mineral present in commercial quantities in the mines worked for copper.

J. Lawrence Smith\* in a description of the minerals of the Wheatley Mine gives the following account of the occurrence of the minerals with depth.

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\* Amer. Jour. of Science, Vol. 20, Second Series, 1855.







".....In opening the vein and descending from the surface for the first thirty feet, the phosphate of lead was very abundant with some galena and carbonate; a little lower down the phosphate was less, and the carbonate more abundant. Wulfenite and anglesite began to appear at 120 feet, the phosphate and carbonate still continued with the galena with fine large crystals of anglesite and considerable wulfenite; at 180 feet, phosphate very much diminished, carbonate and sulphate in fine crystals; arsenate was found here; at 240 feet, blende, calamine and fluor spar appear with considerable dolomite and but little phosphate of lead, galena forming almost the whole lead ore, anglesite is found, but in smaller crystals."

This variation in the character of the ores shows that there has been considerable leaching of the lead and zinc minerals in the upper levels and enrichment at lower levels. The thickness of the enriched zone has not been determined and it is not known whether the deepest workings were still in the enriched zone or in the underlying primary un-enriched portion of the lodes.

One of the most interesting features of these mines in comparison with other lead and zinc mines was the great abundance of pyromorphite present. It was the principal ore mineral found in the upper levels. For a time it caused considerable difficulty in smelting but this was later overcome.

In the deeper levels the galena and sphalerite were about equally abundant. Within the vein certain streaks or pockets contained only galena, others only sphalerite, and others intimate mixtures of the two. Both minerals are coarse grained and due to perfect cleavage are very brittle and readily broken.

The galena is argentiferous, the amount of silver in it varying up to 120 ounces to the ton. According to certain writers the galena averaged from 11 to 16 ounces of silver to the ton but others estimated it to average from 26 to 30 ounces.

The lodes vary in width up to 5 feet with an average of about  $2\frac{1}{2}$  feet. In most places the major part of the lode is composed of gangue material consisting of quartz, decomposed rock constituting clay or gouge with small amounts of the other minerals listed above. In some places the veins contained practically no ore minerals but on the other hand a thickness of 4 feet of solid galena was encountered in one place in the Brookdale mine.

A description of the Wheatley mine by William P. Blake\* states that "the mining operations have sufficiently developed the character of the vein to show beyond a doubt that the ore is distributed in elongated patches or shoots along the vein, having a vertical rather than horizontal extension, and lying parallel with each other. They are also found to dip, not only with the vein, but obliquely upon it, plunging towards the west at an angle of  $45^{\circ}$ . These shoots vary in size from a few inches to four or five feet in transverse section, while their length from above downwards is much greater.

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\* The Wheatley Silver Lead Mines. Mining Magazine and Journal of Geology, Second Series, Vol. 1, pp. 411-418, 1860.







"The distribution of the minerals in the shoots is also an interesting point. Captain Cockin has observed that in passing through a shoot, blende is most abundant on each side, while the central portion is occupied by galena and lead salts."

The following section across Chester County lode, measured by the writer, shows the same characteristics.

	Inches
Foot wall, slickensided gneiss	
Thin streak of galena in shattered quartz-----	2
Barren impure quartz -----	1
Streak of sphalerite in quartz -----	1
Shattered quartz and decomposed rock with nests of white quartz and small bunches of galena -----	31
Streak of galena and quartz with some clay gouge ---	3 to 6
Open fissure, walls lined with quartz crystals with occasional crystals of galena -----	2
Hanging Wall.	

The variation in the width of the vein and the distribution of the ore minerals within the vein make it difficult to estimate the average yield of the lodes. Rogers states that at one place in the Wheatley mine he estimated the lode to yield  $1\frac{1}{4}$  to  $1\frac{1}{2}$  tons of good ore per square (cubic?) fathom and in another place 3 tons. But there are other places where the yield might be only a few pounds per square fathom. According to Blake\* there were more than 4000 feet of drifts along the lode in the Wheatley mine and the amount of ore raised was 1800 tons, most of which yielded 60 per cent of lead and an average of 26 to 30 ounces of silver to the ton. We know that considerable stoping was done and this is probably not included in the 4000 feet of drifts. It is probable that the bulk of the ore came from stopes some of which are described by Rogers as having been carried up to a height of 30 to 55 feet. It would therefore seem probable that the average yield of the lode per square fathom was very low. It must be recognized, however, that at that time little attention was given to the zinc ores as only lead and silver possessed value.

#### Origin.

The lead, zinc, and copper lodes of Chester and Montgomery counties are of hydrothermal origin. They have been formed by deposition from heated solutions probably given off from some deep-seated igneous masses. They are fissure veins and may follow faults wholly or in part. In the Chester County lode the foot-wall is prominently slickensided and in places the hanging wall also shows slickensides. In the Wheatley mine the vein cuts three trap dikes that have been displaced several feet. On the mine dumps one also finds occasional pieces of slickensided rocks. However, one cannot say whether faulting preceded the deposition of the lodes or not. The shattered character of the gangue and ore minerals and the presence of

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\* Op. Cit.







clay gouge and open quartz-lined fissures indicate that there has been at least some displacement following the formation of the lodes.

The lodes are of Triassic or post-Triassic age as proved by the fact that they cut the Triassic shales of the Stockton formation and the trap dikes that are so commonly found as intrusives of the Triassic rocks of the State.

In every case the lodes have undergone secondary changes through the agency of downward percolating waters. The gossan and cavernous quartz of the outcrops, the secondary minerals such as pyromorphite, cerussite, anglesite, calamine, etc., some of which are found at considerable depths, furnish evidence of the extensive alteration which the lodes have undergone.

The abundance of pyromorphite is difficult to explain as there is now no evidence of the source of the phosphoric acid. It is possible that there were some phosphatic beds in the overlying Triassic strata now removed by erosion, but this is only a conjecture.

It seems that Rogers probably over-emphasized the distinctions between the lodes lying within the gneisses and those found in the shale areas although he was correct in pointing out general differences. Undoubtedly the shales tended to cause the deposition of the primary chalcopryite to a greater degree than did the gneisses and vice versa the gneisses had a selective reaction on the solutions causing greater deposition of the galena than is found in the veins enclosed by the Triassic shales.

#### Description of Mines.

Perkiomen Mine. The Perkiomen mine is the oldest of this district. For nearly 60 years no work has been done there and at present only the ruins of the old shafts and the extensive mine dumps furnish evidence of the former operations. It was stated in 1826 that the mine had a 160-foot shaft and drifts aggregating several hundred feet in length driven at different levels. The vein ranged in thickness from 15 inches to 5 feet, with shoots of greater dimensions. The gangue of quartz and barytes carried lead, copper, iron, and zinc minerals and was regarded as a lead mine. When most actively worked in the early 50's, it was considered as a copper mine. There are records of 151 tons of copper ore shipped to England and Baltimore during 1858 and 6½ tons of lead ore sent to the Bay View Smelting Works on Staten Island.

In 1863 the Perkiomen Mining Company issued a prospectus in their attempt to secure capital to reopen the mine. The following excerpts from this pamphlet may therefore in some particulars be unduly optimistic although doubtless essentially correct.

Mr. Charles P. Williams, who calls himself a "Chemist and Mining Geologist" gives the following descriptions:







"Veins of the Property of the Perkiomen Company.

"The several veins on the property of the Perkiomen Mining Company are confined entirely to the sandstone. Their main, though not sole metalliferous ingredients, is therefore some of the combinations of copper; a small amount of galena and the oxidized ores of lead occur in them however. They are made up of quartz, sulphate of Baryta or heavy spar, and gossan or ferruginous matter, with yellow copper ore (chalcopryite, yielding, when pure, 34.5 per cent of copper) and green carbonate (malachite, yielding about fifty-six per cent of metal,) disseminated throughout. Quartz is the predominating vein-stone. Zinc blende occurs, at times, in them in very considerable quantities. The vein on the property of the Perkiomen Mining Company differs in no wise from the other veins in the same formation in the composition and structure of its vein-stuff, consisting, like all the other cupriferous lodes of the district, of quartz, heavy spar and gossan with malachite and copper pyrites. It varies in thickness from two to twenty feet. While it has shown itself in many portions exceedingly rich, the ores appear to be very irregularly disseminated, occurring in heavy bunches and masses rather than being uniformly distributed. The operations thus far conducted in this vein show that the limits of such masses of ore are marked by the occurrence of large deposits of blende. The yield of ore seems to have been about one ton per cubic fathom, and the yield of refined copper about 19 per cent, or 380 pounds per ton of ore.

"A mass of cupriferous minerals 60 feet long and 18 feet wide on the fifty fathom level east of the shaft and increasing in size downward had the appearance of highly productive ground. Ore carrying about 8 per cent copper is reported as remaining in abundance in the stopes on the 10 and 20-fathom levels. West of the shaft on the forty fathom level is a good lode 200 feet long that will yield a large amount of 8 or 10 per cent ore.

"There is also whole ground from five hundred to six hundred feet long, between the Perkiomen and Ecton mines, as yet undeveloped, and there is no reason why this piece of new ground should not be as profitable as any ground in the Perkiomen mine, as there are shafts on each end of it, and there is no other expense required but to drive the levels to open it for stoping."

Ecton Mine. A short distance south of the Perkiomen mine is the old Ecton mine. This mine seems to have been located on a similar but distinct lode. Few detailed descriptions of it are available. The mine dumps would seem to indicate that a fairly large amount of work was done there. On May 1, 1853 at the 54-fathom level the lode was "three feet wide, composed of quartz, spotted with copper pyrites," and at the 66 fathom level it was from 3 to 8 feet wide with "a very promising appearance, but at present poor."

Little or nothing is known of the lode or mine workings at Port Kennedy lode, Shannonville South lode, United mine, Morris mine, and Jug Hollow mine.





Wheatley Mine. The most important mine of the mineral belt of Montgomery and Chester counties is the Wheatley mine. It has been described many times as have also the minerals which were obtained there by mineralogists. The Wheatley, Brookdale, and Phoenix mines were all located on the Wheatley lode. This lode is  $2\frac{1}{2}$  miles south of the business center of Phoenixville.

Rogers in his Geology of Pennsylvania published in 1858 says that in May 1853 this remarkably regular silver-lead vein had been mined at intervals for about 3100 feet. The Wheatley and Brookdale engine-shafts are 2076 feet apart on the lode. In the Wheatley mine the vein has been opened for 1111 feet and in the Brookdale mine for 456 feet. Between the two mines there remains 1501 feet in which the lode has not been proved. The vein is 1 to  $2\frac{1}{2}$  feet wide, averaging 18 inches in the Wheatley mine and 2 feet in the Brookdale mine. The dip of the vein is  $68^{\circ}$  to  $76^{\circ}$  and the lode seems to improve with depth. The gossan is silver-bearing and the proportion of galena increases with depth. This vein is of true igneous origin from a source deep within the earth. It cuts three small dykes of trap rock and therefore is of later date than the dykes.

The mines on the Wheatley lode yielded good ore from several stopes and in 1853 good stoping ground remained untouched. The Wheatley lode has several branch veins which fork off and, for the most part, re-enter the lode, thus completely surrounding a block of wall rock. The branch veins are only a few inches thick but carry good lead ore.

Rogers says "I cannot conclude this description on the Wheatley and Brookdale lodes, and the two mines recently wrought in it, without expressing, in distinct terms, my conviction, that the whole vein, as far as opened, holds out a good promise of permanency and richness, or, in other words, of fair remunerative profit, if efficiently and frugally wrought." The Wheatley shaft at that time was 20 fathoms or 120 feet deep.

Brookdale Mine. The vein in the Brookdale mine has the same character as that in the Wheatley mine, and there is every indication that it is one continuous lode. "Several tons of marketable ore were obtained at no greater depth than some 20 feet; and below this level the vein steadily improves in richness in the shaft. On the whole, the indications of a productive vein in the lower levels of this mine seem encouraging." The shaft was 75 feet deep in 1853.

Phoenix Mine. The Phoenix mine was also opened on the Wheatley lode but it seems to have been worked only to a slight extent. There was a 95-foot shaft on the property in May 1855 and was "developed to an extent of about 400 feet long." This probably means that some drifting was done on the vein.

Chester County Mine. The Chester County lode lies just west of the Wheatley lode and strikes in such a direction as to intersect it if prolonged a few hundred yards. Neither lode has been worked sufficiently to determine whether they do intersect.





The date of opening the Chester County mine is not known but when a new company took possession in June 1850, the mine had four shafts, some drifts, and an 838-foot adit. The adit cut a 5-foot vein, 270 feet from its mouth, but which contained only "gossan and spar." Seven hundred feet from the mouth a so-called "copper vein" was encountered "containing spar, gossan, mundic (pyrite), small quantities of yellow copper ore, and occasional stains of green phosphate of lead." The principal lead lode was encountered at 837 feet. A drift had been driven 185 feet on the copper vein that varied from 22 to 30 inches in width, and on the lead vein there had been 548 feet of drifting done. About 20 tons of dressed ore had been obtained prior to June 1850.

Work continued until June 9, 1853, when it no longer became profitable to work the mine on account of the rise in the cost of mining labor and the increasing abundance of zinc ore encountered for which there was no use. During the three years between June 1850 and June 1853 several shafts were sunk and a large amount of drifting done. On the 10-fathom level there were 1342 feet of drifts, on the 20-fathom level 1130 feet, and on the 30-fathom level 916 feet.

From Nov. 1, 1851 to Nov. 1, 1852 the mine yielded 443 tons of ore. A smelter was erected by the Company at which the output of this mine as well as that from other mines in the vicinity, from Lancaster County, and from New York and Arkansas were reduced.

The vein is approximately vertical and ranges from 2 to 5 feet wide. It consists mostly of clay gouge and shattered quartz carrying lenses of galena and sphalerite.

In 1918 and 1919 the old workings were restored, some drifts were extended, stopes and winzes driven, and a small concentrating mill was erected. One hundred tons of concentrates shipped June 1, 1920 averaged 79 per cent lead and  $7\frac{1}{2}$  ounces of silver per ton. Considerable zinc ore remains at the mine.

Montgomery County Mine. This mine was on a lode about  $\frac{1}{2}$  mile west of the Wheatley lode. In 1853 there was one shaft 118 feet deep, three shallow shafts, and an adit. Besides the main vein, an adit cut 4 parallel veins 3 to 16 inches wide.

Galena, cerussite, and sphalerite were found in considerable abundance and all contained silver, especially the galena, some of which yielded 15 to 18 ounces per ton.

The width of the main lode and its characteristics are not known. Difficulty was experienced in smelting pyromorphite and argentiferous gossan, the principal silver-lead ore.

Charlestown Mine. The Charlestown lode lies more than  $\frac{1}{2}$  mile west of the Wheatley lode. It was worked less than some other lodes, but in 1852 had been opened by an adit for more than 800 feet but at not more than 40 feet below the surface. The lode is in gneiss, dips about  $70^{\circ}$  SE., and is 2 to 4 feet wide, exceeding materially the width of the Wheatley lode. The ore in the shallow adit then existing was





poor, but the vein was so nearly identical with the Wheatley, which was equally impoverished near the surface, that Rogers said of it "I hesitate not to pronounce it, from all its external and general indications, quite as promising a repository of lead."

Other Lodes. No definite information has been obtained regarding the Buckwater, Pennypacker, Napoleon, and Pethericks Penn mines or lodes which are shown on Roger's map in this same neighborhood.

#### Future Development.

At the present time two companies are endeavoring to secure funds to re-open the mines south of Phoenixville. Their interest is in the Wheatley and Chester County lodes. They consider that the history of the region and the data available concerning the ore bodies justify the expenditure of considerable sums of money in re-opening and re-equipping the mines. If they are successful in securing funds these active operations may be resumed at an early date. As in most mining districts there is no positive assurance that the operations will be successful, but there does seem to be considerable justification for a wise and conservative investigation to be made, provided the investors appreciate the true situation, which obviously involves considerable financial risk.

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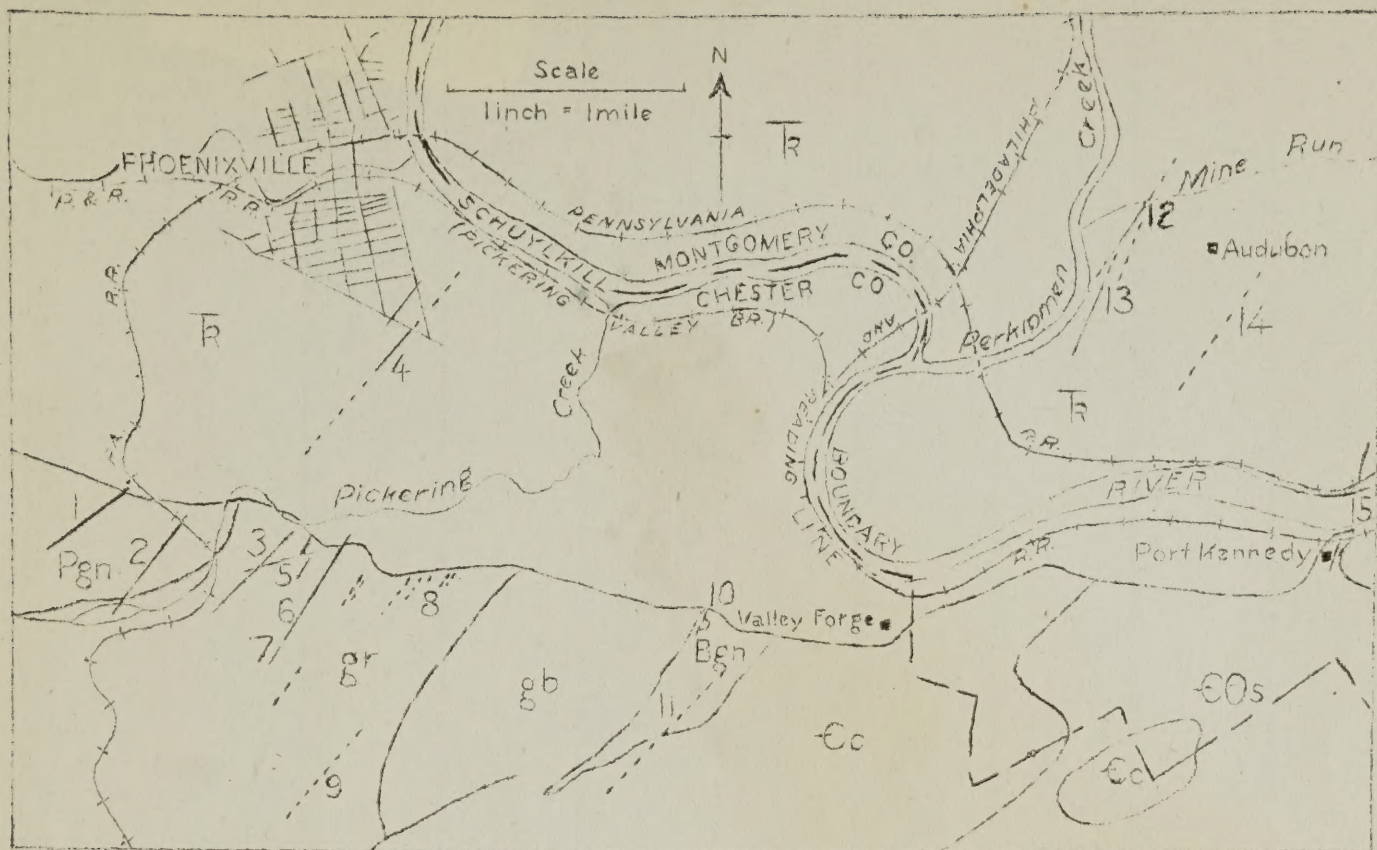
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Location of mines and lodes near Phoenixville.

### LEGEND

#### Formations

T	Triassic, mostly red shale	gb	gabbro
EOs	Shenandoah limestone (Cambro-Ordovician)	gr	granite
Ec	Chickies quartzite (Cambrian)	Pgn	Pickering gneiss
		Bgn	Baltimore gneiss

#### Mines and Lodes.

1. Buckwater	6. Wheatley	11. Pethericks Penn
2. Charlestown	7. Brookdale	12. Perkiomen
3. Montgomery	8. Roberts	13. Ecton
4. Morris	9. Pennypacker	14. Shannonville
5. Chester County	10. Napoleon	15. Port Kennedy

#### Lodes.

—————	location known
-----	extent unknown



